

Remarks

Claims 1, 11, 18-23, 26-40, 42, 43, 45, 46, and 48-61 are pending in this application. Claims 1, 11, 18-23, 26-40, 42, 43, 45, 46, and 48-61 now stand rejected.

Claims 1-10, 12-17, 24-25, 41, 44, and 47 have been cancelled.

Claim 1 is cancelled and replaced by new claim 62.

Specification

A substitute Specification in clean format is attached hereto. The Specification has been formatted with 1.5 spacing between lines to make it more easily readable. No marked-up version of the specification is required as no other amendments have been made.

Claim Objections

Claim 19 cites “liquid media” and not “host liquid media”.

Claim 19 is objected to because the claim number to which this claim depends is missing.

Claim 19 is amended to replace “host” with “hydrocarbon” and to depend from claim 62. Accordingly, the present objections are now moot.

Claim Rejections – 35 USC § 103

Claims 1, 11, 18, 20-23, 26-40, 42, 43, and 50-61 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Piccoli et al. (US Patent 6,118,037) in view of Wismann et al. (WO 01/42392 A2).

Applicant respectfully traverses the present rejection for the following reasons. The present invention is directed to a method for treating hydrocarbon liquids containing a number of impurities. The impurities include thiophene, higher thiophene homologs, and heteroatom compounds having nitrogen and/or oxygen. The method of the invention is dynamic in the sense that the impurities are oxidized and then adsorbed onto a suitable sorbent. The combination of references does not reconstruct the present invention whether considered individually or in combination.

The Office Action attempts to reconstruct the present invention by combining Piccoli with Wismann. Piccoli teaches a process in which impurities are removed from a hydrocarbon liquid by adsorption using an adsorbent. The Office Action admits that Piccoli is deficient in failing to disclose an oxidation step. Wismann is relied upon to correct this deficiency:

Wismann discloses a process similar to Piccoli for treatment of hydrocarbon liquids using an adsorbent (See title and abstract). Wismann also discloses removal of mercaptan sulfur from petroleum distillates by sorption or simultaneous sorption and oxidation (See page 1, lines 7-8). Wismann further discloses that as the mercaptan enters the pores, oxygen from air or some other source, also enters the pores and attacks the mercaptan to convert it to disulfide, which is highly soluble in oil within the pore. This allows a concentration gradient allowing influx of the mercaptan into pores and outflux of disulfides out with the distillate to produce sweet distillate product (See page 3, lines 1-6).

The Office Action

The Office Action correctly recites the teachings of Wismann but misapplies them to the present invention. Wismann is solely directed to the removal of mercaptans from a hydrocarbon liquid while the present invention is directed to the simultaneous removal of a wide variety of impurities - thiophene, higher thiophene homologs, and heteroatom.

In Wismann, pores in the adsorbant are used as sites for bringing together a mercaptan with an oxidizing agent to form an oxidized product such as a disulfide. Interestingly, the resulting disulfide is not adsorbed in Wismann. Indeed, disulfides are not polar molecules and apparently have no tendency to be adsorbed to the adsorbent used in Wismann. Wismann makes this point clear:

As the mercaptan enters the pores, oxygen from air or some other source, also enters the pores. **When the mercaptans adsorb on the surface within the pore, oxygen then attacks it to convert it to disulfide, which is highly soluble in oil within the pore.** Thus, a concentration 5 gradient allowing influx of the mercaptan into the pores and **outflux of the disulfides carried out with the distillate occurs**, resulting in a sweet distillate product.

Wismann, p. 3, ll. 1-6 (emphasis added)

Wisman does not disclose a process in which an impurity is oxidized and then adsorbed by a sorbent as required by the present invention. Instead, Wismann teaches a process in which mercaptans are oxidized to disulfides in pores of the adsorbent with the subsequent release of the disulfide back into the hydrocarbons. Although this fulfills the enunciated goals of Wismann in that the level of sulfides is reduced, the disulfide is not removed as required by the present invention but remains in the hydrocarbon. The results provided in example 2 of Wismann show that after treatment the mercaptan content was only 60 ppm where the mass sulfur content was still high at 0.22 weight percent. The high level of sulfur is in agreement with the notion that the disulfide leaves the pore and enters the hydrocarbon liquid.

With respect to sulfide removal, Piccoli is not compatible with Wismann. Piccoli teaches that sulfides are removed by a first reduction step in which the sulfides are hydrogenated:

The removal of nitrogen and sulfur generally takes place **by hydrogenating treatment** under severe conditions of temperature and pressure, especially for cuts to be sent for hydrocracking and/or reforming. Patent literature is very ample: the removal of sulfur is generally carried out contemporaneously with the demetallation step: examples which can be cited are U.S. Pat. No. 4,746,419 of Amoco Corp., U.S. Pat. No. 4,652,361 of Phillips Petroleum Corp., U.S. Pat. No. 4,585,546 of Mobil where the elimination is carried out with catalysts based on inorganic oxides, for example alumina, modified with compounds/atoms with a hydrogenating function.

Piccoli, col. 1, ll. 33-48.

and

Sulfurated compounds (of the sulfuric and mercaptanic type) can be retained with an NaOH solution as in the Mercox Process.

Type a) methods are specific however for the functional group and therefore when several contaminants having different functional groups must be removed it is necessary to subject the stream to more than one treatment. The type b) adsorption must be selective for contaminants with respect to the main components of the streams and also easy to regenerate. Disclosures in this sense are provided in U.S. Pat. No. 4,831,206 **where the impurities containing sulfur and nitrogen are hydrogenated to hydrogen sulfide and ammonia in a first step** and adsorbed in a second step by contact, which can take place in either liquid or solid phase (150°-290° C., 0.2-2 hours, 100-400 psig), with materials of the zeolitic type (4A, 5A and clinoptilolite). The adsorption beds are regenerated before being released by saturation.

Piccoli, col. 2, ll. 6-23.

It is clear that prior to the present invention, one skilled in the art would not view a combination of Piccoli and Wismann as providing in combination a process in which sulfides are oxidized and then remove by adsorption onto a sorbent since Piccoli calls for a hydrogenation while Wismann calls for an oxidation. Moreover, a proper reading of Wismann also reveals this to be true because the disulfide generated in that reference does not adsorb to the sorbent.

It should also be pointed out that Wismann carries out the oxidation of its process in a different manner than the present invention. In the present invention, the oxidizing agent is combined with the impure hydrocarbon liquid **before** contacting the sorbent while in Wismann:

The sour distillate is trickled down through the bed and air is sparged from the bottom in the form of fine bubbles. The bed is maintained at low pressures (typically normal atmospheric) and between approximately 20°C to 55°C. The sweet distillate will be removed from the bottom. The air stream containing traces of volatile compounds is cleaned by contacting with the sweet distillate.

Wisman, p. 3, ll. 10-14

Clearly, Wismann does not teach a process in which the oxidizing agent is mixed with the impure hydrocarbon liquid prior to contacting the sorbent. Although the present invention is not limited to any particular theory of operation, it is plausible that the difference in the manner of introducing the oxidizing gas is one reason for the difference in operation of the present invention and, in particular, the adsorption of the oxidize impurities in the case of the present invention.

Finally, new independent claim 62 includes the limitation “at least a portion of the impurities being oxidized to mono-oxides and di-oxides.” Neither Piccoli nor Wismann teach a process in which impurities are oxidized to mono-oxides or di-oxides and then adsorbed on a sorbent.

Accordingly, for at least these reasons, claims 1 (now replaced with claim 62), 11, 18, 20-23, 26-40, 42, 43, and 50-61 are allowable under 35 U.S.C. § 103(a) over Piccoli et al. in view of Wismann et al.

Claims 19, 45, and 46 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Piccoli et al. (US Patent 6,118,037) in view of Wismann et al. (WO 01/42392 A2) and further in view of Fleck et al. (US Patent 2,925,381).

Claims 19, 45, and 46 depend from claim 1 (now replaced with claim 62) which is shown above to be allowable. Accordingly, claims 19, 45, and 46 are also allowable under the present rejection.

Claims 48 and 49 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Piccoli et al. (US Patent 6,118,037) in view of Wismann et al. (WO 01/42392 A2) and further in view of Stowe (US Patent 5,035,804).

Claims 48 and 49 depend from claim 1 (now replaced with claim 62) which is shown above to be allowable. Accordingly, claims 48 and 49 are also allowable under the present rejection.

Conclusion

Applicant has made a genuine effort to respond to each of the Examiner's objections and rejections in advancing the prosecution of this case. Applicant believes that all formal and substantive requirements for patentability have been met and that this case is in condition for allowance, which action is respectfully requested. If any additional issues need to be resolved, the Examiner is invited to contact the undersigned at his/her earliest convenience.

The Petition fee of \$555.00 is being charged to our Deposit Account No. 02-3978 via electronic authorization submitted concurrently herewith. Please charge any fees or credit any overpayments as a result of the filing of this paper to our Deposit Account No. 02-3978.

Respectfully submitted,

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